

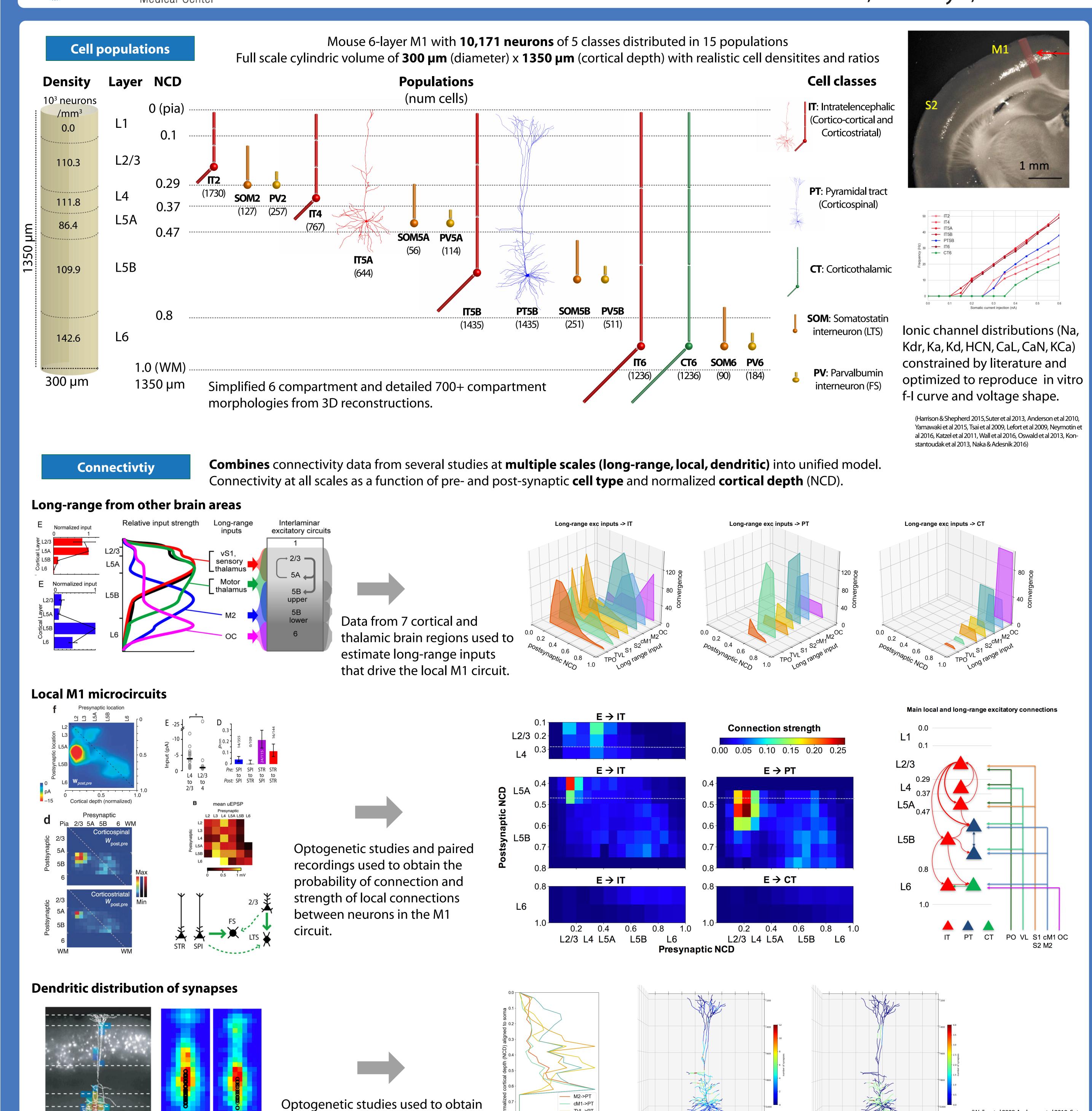
UNDERSTANDING MOTOR NEURAL CODING THROUGH DETAILED SIMULATION OF MOTOR CORTEX MICROCIRCUITS



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- L2/3->PT

VL thalamus -> PT

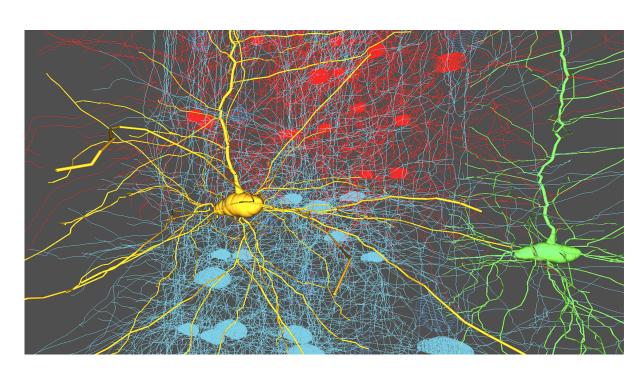
- S2->PT

synaptic density profiles and the

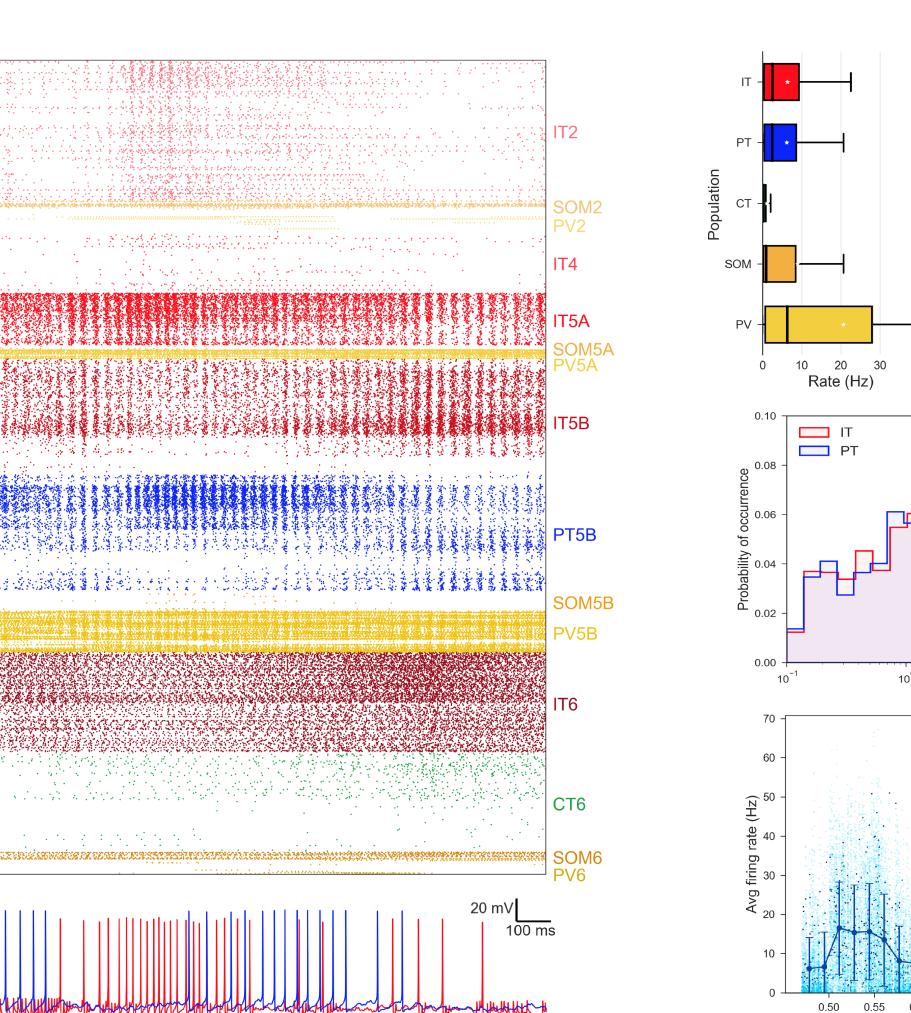
the dendritic tree.

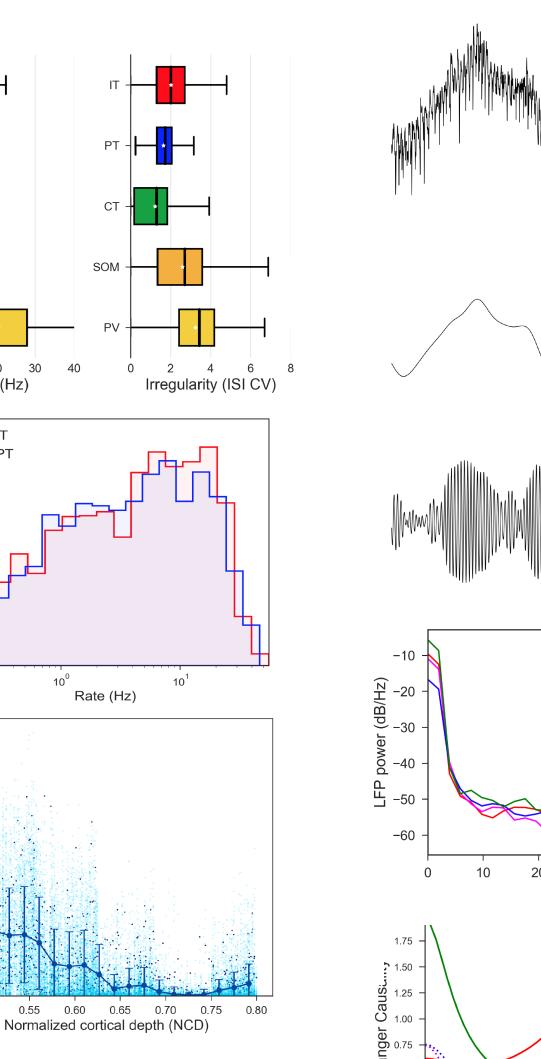
distribution of synaptic inputs across

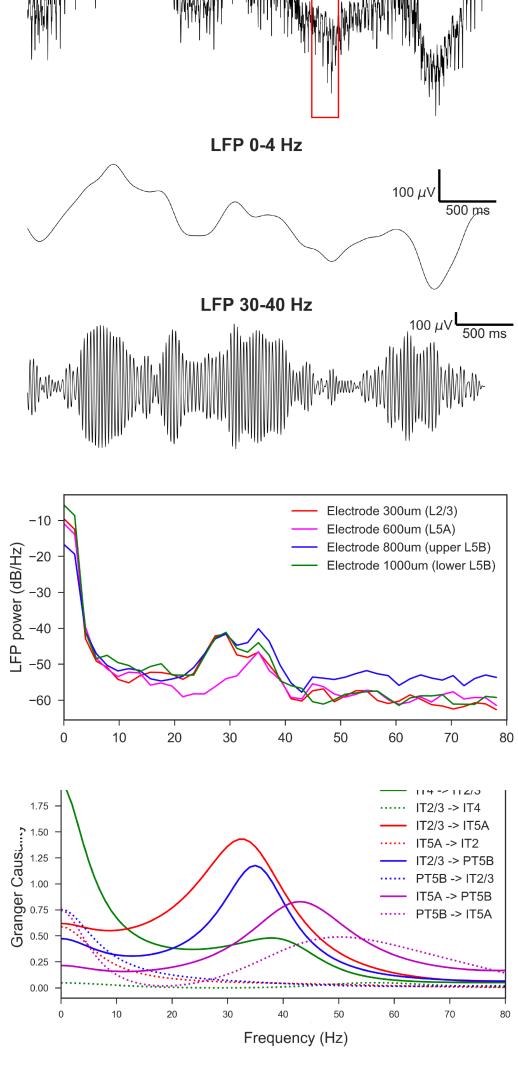
Spontaneous M1 activity (driven by long-range inputs)



- Spontaneous firing rates exhibit distributions and spatial properties that match cortical data.
- Neural activity depends on cell class, cortical layer and sublaminar location, e.g. PT activity within layer 5B decreased with cortical depth.
- LFP oscillations in the delta and beta/gamma range emerged in the absence of rhythmic external inputs; delta phase modulated gamma amplitude.
- Information flowed from IT->PT but not opposite direction (peak in beta/gamma).

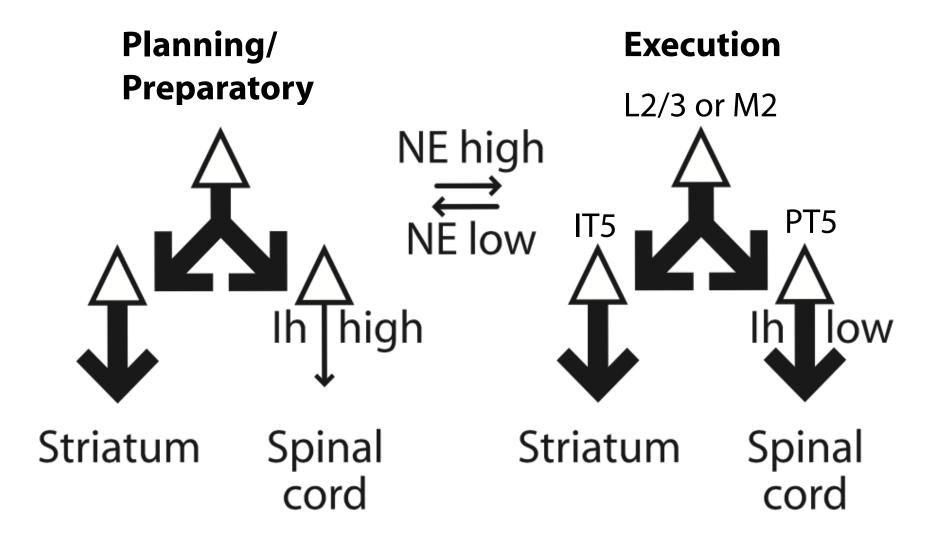




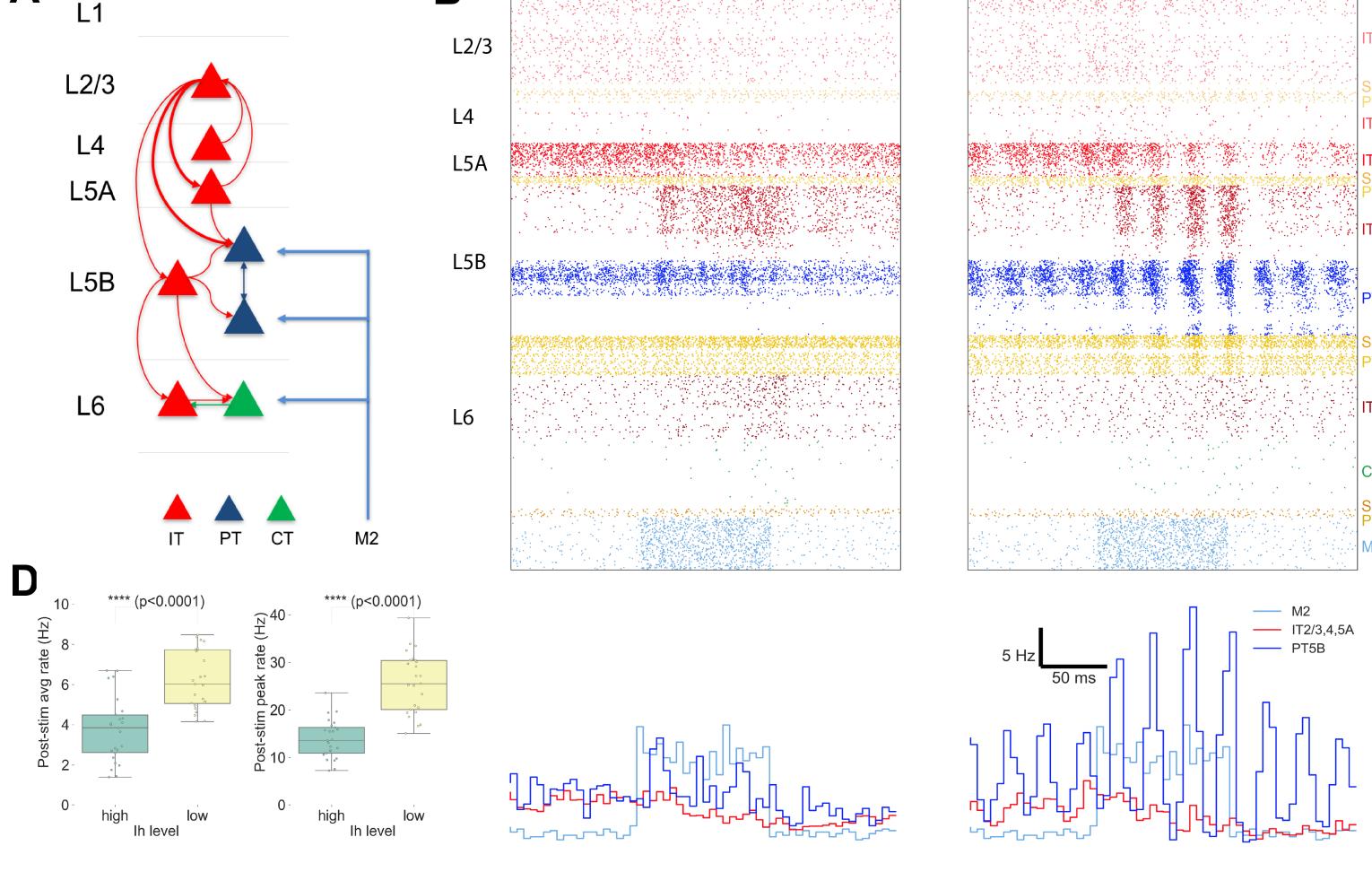


M1 response to long-range inputs and Ih modulation

Modulation of HCN current (Ih) by norepinephrine (NE) hypothesized as potential mechanism to switch between motor planning and execution



- Identified two pathways to activate corticospinal output:
- 1) Sensory-related inputs (e.g. thalamus) --> M1 upper layers --> M1 PT cells
- 2) Motor-related inputs (e.g. S2) --> M1 PT cells
- Downregulation of Ih facilitates synaptic integration of inputs and increases PT corticostpinal output.
- Statistically significant effect of Ih from both thalamic and S2 inputs (N=25 models with 5 wiring x 5 input seeds)



Conclusions

(Weiler et al 2008, Anderson et al 2010, Suter

et al 2015, Hooks et al 2013, Kiritani et al 2012

awaki & Shepherd 2015, Yamawaki et al 2015

Naka & Adesnik 2016, Katzel et al 2011, Fino &

Lefort et al 2009, Apicella et al 2011, Yam-

Yuste 2011, Mao et al 2011)

S2 -> PT

- · Detailed computational model of motor cortex (M1) circuits based on experimental data.
- · M1 is the main region responsible for projecting to spinal cord and producing movement

·The model be used to decipher how motor information is encoded, understand motor disorders, develop pharmacological or neurostimulation treatments, and contribute to the advancement of brain-machine interfaces for spinal cord injury patients.

Websites Lab web: www.neurosimlab.org

Software tool: www.netpyne.org

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